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Achievement Motive and Cognitive Stiles when Successfully Study Physics

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Abstract

The article describes the problem of motivating first-year students to study a complicated material of physics. The methodology of a team competition has been worked out to be implemented during the classes devoted to solving tasks in physics with the first year students majoring in engineering. Thus, special conditions are created for the student activity encouraged by the urge to achieve success. It has been shown that organization of a team competition in teaching physics helps students to feel an achievement motive in studying physics. The ways of forming the competing student teams have been studied in relation to sociometry and cognitive styles. The experiment results prompted the recommendations on forming the composition of competing teams in high schools and universities.

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Keywords: achievement motive; cognitive stiles; methods of training physics; formation of teams; teams competition

1. Introduction

Nowadays, reduction of the hours allocated for classes of physics and mathematics in high schools is the biggest problem of natural sciences education. Insufficient basic knowledge stresses out first-year students majoring in natural sciences in universities. Not all of them manage to overcome this contradiction between the required and the existing level of knowledge in physics and mathematics during their first semester in higher schools.

Potentially teachable students in high school strive for good result in the first years, but cannot reach them due to the above mentioned reasons. Motivation is the main reason for one's success. Therefore, it is of utmost importance

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to create the conditions that would ensure the predominance of students' motivation to study over the fear and uncertainty caused by the challenging subject of physics.

The issues of motivation and levels of mental representation of the reality have long been studied by psychologists. Distinction of sensual and ideal representation of reality might be traced to Plato and Aristotle. Recently following types of representations of reality were proposed by I.L. Prokopchik-Gailo [1]. In accordance with [1] human mental reflection is a system, which contains hierarchical levels, depending on the types of representations of reality. Each level of the system has its own emergent properties. Types of thinking in terms of the system are differentiated depending on the mental elements of the corresponding level. Detailed description of these types of representation focusing on training process we made in paper by T.N. Gnitetskaya [2]. In this paper we just named levels of representation of reality.

- **Zero** level – is a system-forming environment, where unconscious response is carried out in the form of reflex, while there is no thinking.
- **First** level goes after the level called system- forming environment where unconscious response occurs in the form of a reflex, and where there is no thinking. Let's assume that this level is formed at first-year of education in all cases. The first level is implemented through a feeling using conscious subjective response that provides such sensory-perceptual thinking as handling feelings.
- The **second** level is in charge of forming of visual thinking as handling specific, generalized and other images, and emergent properties are multipolarity dichotomous self and world–perception.
- The next **third** level one where the dichotomous perception disappears - emergent properties have only a verbal nature. It is the level of scientific thinking as handling scientific concepts, laws and principles.
- The highest level is the **fourth** – this level of completes the range of mental reflection of the world by a modern man.

Student who experience such problem are those whose level of mental reflection does not exceed the second one. The desired level is formed through enhanced learning and absorbing in one's study. If the goal achievement is motivated it will happen pretty quickly.

Achievement motive was studied in detail in the mid-twentieth century by a group of psychologists including D. McClelland, J. Atkinson, Hekhauzen etc. and was subsequently used in other studies (see, for example, N.A. Almaev [3]). Achievement motive was first defined as the «competition with standard of excellence» [4] (McClelland et al, 1953 , P.110). Need for competition with a peer is natural for student but at the same time it may lead to bitter frustration in the case of failure and subsequent development of the fear of failure (Heckhausen, 1967) [5]. How risk of frustration and failure may be moderated? How need for competition with a peer might be transformed into the competition with standard of excellence? This paper makes an example of a special organization of independent activity of first-year students of engineering majors at solving physical problems classes where many students experience a lot of problems.

2. Team as a moderator of peer competition when solving physical problems

In the framework of this paper, it is proposed to organize the team competition, in which each student has his own place. Teamwork where the strong one helps the weak one reduces the risk of personal frustration in the case of student's failure. It creates conditions of collective responsibility.

Moreover, McClelland thought that there is a positive competition result even if the goal was not reached – "The subject cannot reach the goal, but taking a part in such competition is a sufficient reason to consider the goal to be dictated by the achievement motive"[4].

Seminars in physics are included in the scenario of the study of a module's topic as a practicum in solving physical problems and are held every week [8].

The main goal of addressing to such form of practical training is to create conditions for the peer competition with the standard of excellence through peer team competition, during which each student performs complex analytical operations relevant to scientific and systemic levels of mental reflection. At the same time, these conditions should not favor the avoidance motive that always accompanies and counteracts the achievement motive according the J. Atkinson's theory [5].

The methodology of team competition in solving physical problems suggests involving the method of semantic

structures and is implemented in several stages.

The first stage – is preparation for the competition. A teacher gives students a simple task one for all for home preparation. The analysis and solution of the problem is carried out using the method of semantic structures. The method of semantic structures described in detail in [6] and is a way of structuring learning material. Students carefully read conditions of the problem and write down all its concepts. The content of each concept is analyzed in detail using the workbook; students find definitions, formulations, establish links with studied concepts to understand the meaning of the concept from the problem's condition. Since the condition is often complemented by the data contained in the question of the problem, the question is subject to the same analysis. All information obtained during the analysis is presented in the form of semantic structure of the problem's condition. With that purpose the concepts are put to the upper level of generalization. Concepts and formulations included in the problem's condition are located at the level below and so on down to the lowest level of generalization where further specification is impossible (the most simple concepts remain) or is not required under this problem.

During the formation of semantic structure, the problem solution becomes clear. It can be represented in the traditional form of relations or in the form of semantic structure.

The next (second) stage is implemented at the lecture after checking homework. Teams are given tasks similar to their homework but with slight changes in the condition, specific for every team. Teams discuss the condition of the problem for 15 minutes building its structure and performing the solution in the form of semantic structure.

At the third stage, the competition of psychologically matched teams is performed in a form of a conference. Delegated students make reports. Their assessment is carried out at the seminar reports – it can be negative. To reduce the negative impact of negative assessment on student's motivation - the assessment is carried out by two opponents - "black" once from enemy group and "white" ones from home group. "White" speaks first; his task is to allocate the positive side of the report, on the base of which to put the highest possible mark. The task of the "black" opponent is to emphasize all defects of the report and to offer an assessment taking into account these shortcomings. A teacher listens to both opponents and chooses one of these assessments in his closing remarks. If it is necessary, a teacher suggests his own analysis structure and the problem solution. But whatever a teacher's choice would be, the goal is achieved, and positive assessment, even if it was not received, was heard from other students. So achievement motive has been realized.

3. Sociometric method of forming the competing teams.

To achieve the goal, it was required to allocate teams with psychologically compatible students. In such team a weak student has an opportunity to solve (whether correctly or not) complex problems with the support of his peers protecting him from falling down and frustration in case of failure.

A group of twenty four people were divided into small competing teams of six-seven people according to the J. Moreno's method of diagnosis of interpersonal relationships [6], the essence of which is as follows. Each student chooses three candidates for three types of activities answering the following questions:

1. If you have to carry out an intellectual work, who would you like to work with? (Write the names of three students).

2. If you have to work in a group (organizational work), who would you proposed as a leader? (Write three names of group mates).

3. Who would you like to spend your leisure time with? (Write three names of group mates).

Obtained results are distributed by categories in the diagram's layers For example, the answers to the first question in the group of 20 people were distributed in the diagram as shown in figure 1.

Numbers in circles correspond to students' individual numbers. Numbers without circles indicate the amount of students who chose the number of this student. Thus, the 9-10 range should have stars, the 7-8 range - leaders, the 5-6 range – favorites, 3-4 – ignored ones, 1-2 – isolated ones, 0 – rejected ones.

1. The first diagram shows that ten students wish to conduct intellectual activity with a student number ten. He is a star, the maximum possible number of students elected him. Student number three was elected by six people.

2. The second diagram shows that `ten students wish to conduct organizational activity with a student number three. He is a star in this kind of activity. Student number sixteen was elected by six people. Absence of leaders is a

characteristic feature of this group.

Likewise, personality types are distinguished by organizational and emotional activities. Analyzing the diagram, a teacher forms groups in such way that each of them can have a star or a leader, preferred ones, ignore ones, isolated ones, rejected ones(see Figure 1).

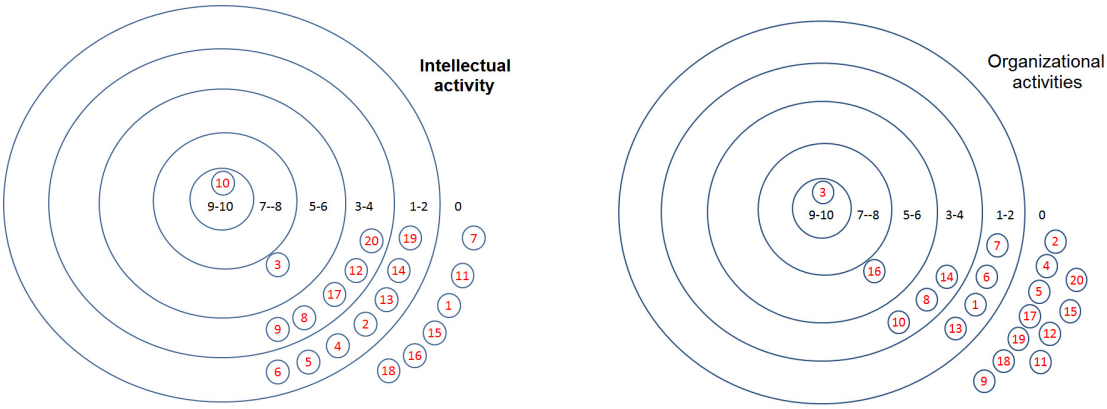


Fig. 1. Diagrams Example "Marking out leaders by intellectual and organizational activities in the group"

Such team composition according to D. Moreno [6] promotes effective cooperation of its members.

Despite all advantages of the described sociometric way of dividing students into coordinated groups, it fails to cover the individual peculiarities of thinking – a successful combination of which provides for the efficient performance of a group. In the adolescent period, when these features just begin to reveal, creation of favorable conditions in a team as well as competition will invariably ensure the development of intellectual skills among schoolchildren. We suggest that high schools conduct competition among the groups formed with the help of cognitive styles of their participants. That was the context of the experimental research of the participant cognitive styles described in the next paragraph.

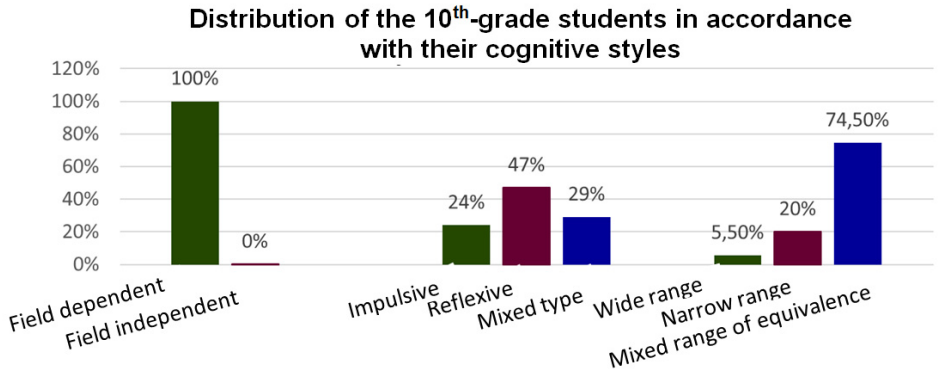
4. Forming of competing teams in accordance with cognitive styles.

The experiment involved 55 participants of 10th grade in a Vladivostok high school, Russia. According to Kholodnaya M.A. [9], every cognitive style belongs to two extreme forms of intellectual behavior. Totally, there are about twenty cognitive styles. We have selected only the ones that include elements of academic activity. These styles include: field dependence - field independence – a degree of student's dependence on their environment, ranging from complete dependence (field dependence) to absolute independence (field independence); impulsiveness – reflectivity, characterizes the student's speed of decision-making; narrow – wide range of equivalence, characterizes the predominance of analysis or synthesis processes in student's thinking activity. A psychological type of a student identifies the degree of their proximity to the extreme sides of each style called characteristics of the personal cognitive sphere.

Results of the test conducted via the methods [11, 12] have allowed distributing the students in accordance with the poles of corresponding styles. The distribution scheme is shown on Picture 2. It shows that 100% of the respondents reveal field dependence. It is recommended that all of them become involved in the academic process organized in various team forms. In order to form the groups it is necessary to use the characteristics of the remaining styles. Distribution of the students by impulsiveness – reflectivity has shown that impulsive students (those who give fast and incorrect answers) account only for 24% of the total number of respondents; the percentage of reflexive students (those who give slow and correct answers) is twice as much – 47%. The remaining respondents (29%) can be described as mixed – possessing both features. It can be recommended to include both types of students (reflexive and impulsive) into the teams. Picture 2 shows that only 5.5% of the students show an obvious

pole of the equivalence range (a synthetic feature); 74.5% of the students have a balance between the processes of analysis and synthesis, i.e. possess mixed poles.

Can the results that show the priority of the mixed type in the style of equivalence range in the 10th grade be accidental? In 1998 the dissertation of Protasova I.N. [10] described the results of an experiment on the influence of academic activity on the formation of the style which she calls analyticity –syntheticity. The research revealed the trend of changing the features of analyticity and syntheticity into a mixed type, which contained both of them. The influence of education on the constant growth of synthetic features of students is quite valid if we study this phenomenon with regard to the intra- and inter-object connections.



The logics of academic process and academic course, especially a course of physics, relies on object connections. The degree of physical phenomena perception correlates with the level of the skills of establishing connections between theoretical and experimental facts and factors. Hence, an additional suggestion – to organize the process of teaching physics in the manner of revealing the system of intra- and inter-object connection in the content of physics. Thus, a student's belonging to an impulsive or a reflexive type is a criterion of forming the teams for this group of students. Ideally, a team should include an equal number of students of reflexive and impulsive types. The choice of students for these teams can be made with the help of sociometric methods described above.

SUMMARY

The difference of proposed methodology of team competition in solving physical problems is it excludes the facts of victory and defeat of a student. The team considers a victory as a personal success of each member. In case of defeat, teams' factor of psychological consistence reduces the negative impact caused by personal responsibility for the failure. Psychological and emotional stresses cause no discomfort but a common desire to compete acquiring the "do better" function of achievement motive.

Teamwork is notable for its quickness and intensity that allow setting a high standard of quality and complicating further tasks. These circumstances make it possible to move to a high level of mental reflection and allow first-year students to form independent activity skills in learning in short time.

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